Montana
Office of Public Instruction
Denise Juneau, State Superintendent
In-state toll free 1-888-231-9393
opi.mt.gov

Mathematic Model Teaching Unit

Native American Designs

Created by: Lisa Scott

Grade 7 – Approximate Duration: 135 minutes

Stage 1 Desired Results

Established Goals:

Geometric Reasoning Mathematics Content Standard 3: A student, applying reasoning and problem solving, will understand geometric properties, spatial relationships, and transformation of shapes, and will use spatial reasoning and geometric models to analyze mathematical situations within a variety of relevant cultural contexts, including those of Montana American Indians.

- **3.3 Transformations including Dilations:** Define, identify, and execute transformations including translations, rotations, reflections, and dilations with appropriate technology.

IEFA: Essential Understanding 1: There is great diversity among the 12 tribal Nations of Montana in their languages, cultures, histories and governments. Each Nation has a distinct and unique cultural heritage that contributes to modern Montana.

IEFA: Essential Understanding 2: There is great diversity among individual American Indians as identity is developed, defined and redefined by entities, organizations and people. A continuum of Indian identity, unique to each individual, ranges from assimilated to traditional. There is no generic American Indian.

Understandings:	Essential Questions:
Students will understand… • how to identify the different planar transformations and symmetries in Native American designs. • how to use a geometry drawing utility to create their own design.	• How are the planar transformations of reflection, rotation and translation defined? • How are the planar transformations constructed using a geometry drawing utility? • How are line symmetry and rotational symmetry identified and defined?
Students will be able to… • mathematically define reflection, rotation, translation, line of symmetry and rotational symmetry. • describe and demonstrate each transformation and symmetry on a Native American design. • construct a reflection, rotation and translation using a geometry drawing utility. • identify and create a line of symmetry in a Native American design. • identify and create rotational symmetry in a Native American design. • create a design using a geometry drawing utility.	*Students will know…* • the definitions of transformation, reflection, rotation, translation, line of symmetry and rotational symmetry.

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Stage 2 Assessment Evidence

Performance Tasks: Students create their own designs. The design includes a reflection, rotation, translation, line of symmetry, and rotational symmetry. Designs are turned in and graded.
Other Evidence: Observation of identifying the transformations and symmetries. Participation in class demonstrations and discussions. Individual questioning of students.

Stage 3 Learning Plan

I. **Teacher Preparation:** Create a PowerPoint
   a. The PowerPoint contains information which will be presented to students. Go to the Morning Star Gallery homepage, http://www.morningstargallery.com/index.html, to complete the preparation needed. Review images to use from the Morning Star Gallery. Select seven various images. Follow the format found in the example slide as a guide, duplicate as needed.

II. **Learning Activities:** Native American Designs
   a. Handout a copy of the PowerPoint presentation "Native American Designs" to each student. Discuss the definitions for a pre-image, image, reflection, rotation, translation, line of symmetry and rotational symmetry.
      i. Have students work in pairs to identify any translations, reflections and rotations in each picture. Students should explain their reasoning for each transformation identified to each other and prepare to share the reasons during the class discussion.
      ii. Have students find and draw line and rotation symmetries on the Native American designs. Students should explain their reasoning for each type of symmetry identified to each other and prepare to share the reasons during the class discussion.
      iii. Project the PowerPoint onto the SMART Board (if available) or a whiteboard and have pairs take turns drawing in their transformations and symmetries. The pairs of students should explain their reasoning of each transformation and symmetry.
   b. Introduce a Geometry drawing utility such as Geometer's Sketchpad, Cabri or GeoGebra. You can download GeoGebra for free from http://www.geogebra.org.
      i. Demonstrate the drawing utility on the teacher computer while projecting with a LCD.
      ii. Have students working individually or in pairs on a drawing utility during the demonstration.
      iii. Encourage Free Play. Have students play with the free hand tools, point, compass, and segment. Use the selection arrow and text tool. Demonstrate how to undo objects.
      iv. Demonstrate how to construct a polygon. Perform a reflection of the polygon over a line. Demonstrate the "click and drag" and how to change the color of the image. Show a reflection over a line that intersects the figure and a reflection over a line that does not intersect the figure by dragging the pre-image or image.
         1. Ask students to describe what they notice about the pre-image and the image as they click and drag points and sides of the pre-image or the image. (Students should notice that the pre-image and the image are always mirror images of each other over the line of reflection and the corresponding points of the pre-image and the image is always equidistant to the line of reflection.)
         2. If students have a difficult time seeing the pre-image and the image are always equidistant to the line of reflection, have them construct a segment from a point

on the pre-image and the corresponding image point. Construct the point of intersection between this segment and the line of reflection. Measure the distance from the pre-image point to the point of intersection between the segment and the line of reflection and measure the distance from the image point and the point of intersection between the segment and the line of reflection. From this construction, the students should see that the segment and the line of reflection are perpendicular to each other. This should lead students to writing a more formal definition for reflection. A **reflection** over a line is a transformation in a plane where each point of the original figure (pre-image) has an image that is the same distance from the line of reflection as the pre-image point. The line of reflection is the perpendicular bisector of the segment joining every point and its image.

v. Perform a rotation of the constructed polygon around a marked point (center of rotation) by a fixed angle. Demonstrate the "click and drag" and change the color of the image.
    1. Ask students to describe what they notice about the pre-image and the image as they click and drag points and sides of the pre-image or the image. (Students should notice the corresponding points of the pre-image and the image is always equidistant to the center of rotation.)
    2. If students have a difficult time seeing the pre-image and the image are always equidistant to the center of rotation, have them construct a segment from a point on the pre-image to the center of rotation and the corresponding image point to the center of rotation. Measure the distance from the pre-image point to the center of rotation and measure the distance from the corresponding image point to the center of rotation. From this construction, the students should see that these segments are equal in length. Have students measure the angel formed by the segments drawn from the center of rotation to the pre-image and image points. Students should notice that this angel is equal to the angel of rotation they determined during the construction of the rotation. This should lead students to writing a more formal definition for a rotation. A **rotation** is a transformation in a plane that moves every point around a fixed point (usually the origin) in a given direction by a given angle measure. Rotations > 0° are counterclockwise. Rotations < 0° are clockwise.

vi. Demonstrate a translation by a marked vector. Demonstrate the "click and drag" and change the color of the image.
    1. Ask students to describe what they notice about the pre-image and the image as they click and drag points and sides of the pre-image or the image. (Students should notice the distance between the corresponding points of the pre-image and the image is the same as the length of the vector and the image moves in the same direction the vector points.)
    2. If students have a difficult time seeing the distance between the corresponding points of the pre-image and the image is the same as the length of the vector, have them construct a segment from a point on the pre-image to the corresponding image point and measure the length of the segment. Measure the

length of the vector. This should lead students to writing a more formal definition for a translation. A **translation** is a transformation in a plane that moves every point in the pre-image the same distance in the same direction.

vii. Show how to hide objects that the students don't want seen but are necessary for the construction of the transformation.

viii. Ask students to work on their designs. Circulate and help as needed.

III. Summary: Native American Designs are rich with transformational geometry. This lesson introduced three transformations. These included a reflection, a rotation, and a translation. This lesson also addressed the definition for a line of symmetry and rotational symmetry using Native American Designs.

IV. Materials:

- Teacher computer
- LCD projector and SMART Board (if available)
- PowerPoint of Native American Designs
- Computers or calculators with Geometer's Sketchpad, Cabri or GeoGebra for each student or pairs of students
- Copies of Native American Designs PowerPoint pgs. 1-10 for each student
- Rubric for each student
- colored pencils or markers

Name_____

Native American Design Grade Sheet

1. Create your design using a Geometry drawing utility such as Geometer's Sketchpad, GeoGebra, or Cabri.

2. Print your design. (5 points) _____

3. Include a reflection (blue), translation (red) and rotation (yellow) in your design. (5 points each, total 15 points) _____

4. Your design must have at least one line of symmetry (green). (5 points)
_____

5. Your design must have at least one example of rotational symmetry (purple). (5 points)
_____

6. Does your design resemble any of the patterns seen in the PowerPoint of Native American Designs? If so, which tribal group does it most closely associate with? If not, explain how it is different. (15 points) _____
_____
_____
_____

7. Which images, if any featured in the Native American Designs PowerPoint, represent designs from Montana tribes? You may use http://www.opi.mt.gov/pdf/IndianEd/Resources/MTIndiansHistoryLocation.pdf, if needed. (5 points) _____
_____

8. You will also receive up to 5 points for design originality. (5 points)
_____

9. Score out of 55 total points possible _____